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Pr9913 - Specification for Acoustic Enclosed Generators at Unitywater Sites (Supply and Installation)

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Contents

List of Tables

1. Purpose

The purpose of this Specification is to define Unitywater requirements for manufacturing and installation of fixed permanent generating sets at Unitywater sites.

This Specification defines quality, performance, reliability, durability, safety and appearance requirements for these installations.

2. Scope

This Specification applies to the generating set design, manufacture, supply, testing, installation and commissioning work at Unitywater's sites.

The generating sets are required to provide standby power during a mains power failure or for load shedding requirements of the electricity Supply Authority or Unitywater's electricity retailer.

Generating sets shall start automatically and operate all the site processes and facilities with the voltage at the alternator terminals not falling below 0.9 pu.

The scope includes, but is not limited to, the provision of the following items associated with the design, manufacture, supply, testing, installation and commissioning of the generating sets:

- Diesel engine;
- Alternator;
- Weatherproof and acoustic enclosure;
- Structure over to provide weather protection (roof cover or building structure);
- Exhaust system;
- Acoustic noise attenuation on exhaust system;
- Governor system;
- Governor excitation system;
- Automatic engine starting system;
- Engine cooling system;
- Skid mounted fuel tank;
- Electrical switchboard and control and indication panel;
- Automatic controls including synchroniser (where applicable);
- Battery and charger systems for control and auxiliary systems;
- Earthing system and protection;
- Design and documentation, preparation of workshop drawings, such as constructed drawings, inspection and test plans, operation and maintenance manuals, etc.;
- Supply, installation, testing and commissioning of all equipment including test results;
- Maintenance support during defects liability period.

3. Technical Requirements

3.1. General Requirements

3.1.1 General Design Aspects

3.1.1.1 The design shall be carried out in conjunction with the Scope of Work or the Principal's Project Requirements or any other overarching document that details the specific requirements for the work.

3.1.1.2 Designs must address to the greatest practicable extent at least the following requirements:

- Safe equipment for construction, commissioning, operation, maintenance repair, removal and decommissioning activities;
- The equipment and associated practices shall be cost effective and provide the lowest total cost of ownership and assure any adverse effect on other associated systems is minimised;
- Maintenance and repair requirements shall be able to be carried out in the shortest possible time with maximum availability of plant and associated systems;
- Compliance with Unitywater specifications, practices and legal requirements;
- All equipment provided to Unitywater is fit for purpose and is fully maintainable for the duration of its whole life;
- Provide Unitywater with standardised, streamlined and coherent systems;
- To ensure high reliability, low maintenance and high availability systems; and
- All electrical systems shall be provided with appropriate isolation facilities in line with statutory requirements, Unitywater specifications and operational requirements to assure that all electrical systems can be safely, readily and appropriately isolated and locked.

3.1.2 General Site, Service Conditions, Design Life Aspects

3.1.2.1 Generating sets shall be designed to operate as a standby generating set and be available to run 24 hours per day 365 days per year with a design life of 40 years.

3.1.2.2 Electrical equipment shall be designed to operate in following environmental conditions and appropriate de-rating factors shall be applied:

- Coastal environment in close proximity to the ocean;
- Wet conditions;
- Relative humidity up to 95%;
- Ambient temperature up to 39 °C;
- Minimum ambient temperature to -5 °C;
- Cyclone Region as per AS/NZS 1170.2; and
- Temperature rises due to solar radiation and heat generated by the equipment itself.

3.1.2.3 Particular attention shall be paid to high corrosion resistance for all externally mounted equipment to achieve corrosion resistance and protection that ensures the life expectancies listed are achieved or bettered.

3.1.2.4 Generating sets shall be sized such that it is capable of supplying the load for the site for periods of time during mains power outages or for load shedding requirements when agreed with the Electricity Supply Authority or the electrical retailer. Generating sets shall be sized for a Standby application.

3.1.3 Equipment and Fault Co-ordination

3.1.3.1 The design shall ensure that every item of equipment is suitable for operation at the required fault.

3.1.3.2 Protective equipment shall be fully co-ordinated so that no item is called upon to break fault current in excess of its fault rating. This shall include control circuit breakers if 230 Vac control is used. Control circuit shall be fault limited to less than 5 kA.

3.1.3.3 Power and control cable protection shall be such that the energy let through by the protective device does not exceed the level permitted for that cable by AS/NZS 3008.1.1.

3.1.3.4 If fault limiting devices or co-ordinated circuit breakers are used, then these shall be fully rated for the fault level specified and be labelled as per Arc Flash Assessment.

3.1.3.5 Protective Device must comply with the approved Arc Flash Assessment document completed as per UW specification *Pr10618 - Power System Analysis and Arc Flash Studies*.

3.1.4 Design for Safety

3.1.4.1 Systems shall be designed and constructed as far as practicable to protect against foreseeable misuse and damage to the facilities and equipment and to extend the safe operation and maintenance of the installations over the duration of the nominated asset life without need of rehabilitation.

3.1.4.2 Due consideration shall be made in the design of the equipment to simplify installation and termination of field cables.

3.1.4.3 All necessary safety facilities and mechanisms shall be installed to assure that there are no exposed live conductors when any door is open. This is to prevent accidental contact with otherwise exposed live circuits behind doors or hinged panels that may be opened without special tools and also when specifically directed within the Scope of Works or the Principal's Project Requirements or any other overarching document that details the specific requirements for the work.

3.1.5 Mandated Equipment

3.1.5.1 The preferred equipment list for automation, electrical and instrumentation equipment is outlined in *F10678 - Accepted Electrical Equipment List*.

3.1.5.2 All equipment supplied to Unitywater shall be strictly in accordance with this preferred equipment list.

3.1.6 Access to Equipment

3.1.6.1 All equipment shall be located and installed so that it will be readily and safely accessible for operation and maintenance (sufficient space for full door open servicing activities). Special care shall be taken to ensure this requirement is met for all doors and that the door can be fully opened and access gained to the required equipment.

3.1.6.2 AS3000 clearances will be required for all opening doors or access panels.

3.1.6.3 The equipment layout shall provide adequate access for operation with all indicators and instrumentation in easy to read locations.

3.1.6.4 All electrical and instrumentation equipment that requires scheduled or unscheduled maintenance or periodic access, shall be located to allow unobstructed, easy and safe access for maintenance, removal and replacement of items. Operator interfaces and shall be mounted between 500mm and 1600mm above working floor height.

3.1.7 Design Review

3.1.7.1 Unitywater will carry out a design review for general compliance with this specification and relevant Australian Standards.

3.1.8 Design Verification

3.1.8.1 All items which are designed shall be design checked or verified.

3.1.8.2 The design check or verification shall be undertaken by a Registered Professional Engineer of Queensland (RPEQ) from the Board of Professional Engineers Queensland, in the category appropriate to the item being design checked or verified.

3.1.9 Hazardous Materials

3.1.9.1 The following hazardous materials are prohibited and shall not be used in any equipment or packaging:

- Asbestos;
- Cadmium or Cadmium Plating;
- Copper Chrome Arsenate (CCA) Treated Timber; and
- Polychlorinated Biphenyls (PCB).

3.1.9.2 Approved alternatives to cadmium plating are zinc plating (chromate converted) and stainless steel.

3.1.9.3 Any other hazardous materials used in the design and construction of equipment shall be submitted to Unitywater for approval prior to the items being used.

3.1.10 Environmental Design Aspects

3.1.10.1 All designs, plant and equipment shall be arranged and implemented as far as practicable to achieve the following:

- Ensuring that regulatory requirements to which Unitywater is obligated to are complied with sustainably;
- Ensuring that life cycle management aspects and related environmental consequences can be sustainably addressed; and
- Contributing to carbon footprint and energy cost minimisation.

3.1.11 Corrosion Protection

3.1.11.1 All equipment and fixings shall be selected so that it is suitable for the corrosive effect of the environment in which it is installed. The equipment shall provide a service life as nominated in Section 3.1.2.1 without excessive maintenance.

3.1.11.2 Where dissimilar metals are installed in close proximity to one another, care shall be exercised to avoid the effects of galvanic corrosion. The components shall be:

- Made from compatible material;
- Inherently sealed from the environment, e.g. stainless steel;
- Electrically isolated from each other by separation using either:
  - A minimum 3 mm air gap; or
  - A minimum 2 mm of UV resistant, non-hygroscopic material such as rubber, PVC or polythene; or
  - Interstitial spacer.

3.1.11.3 Welding of corrosion-protected surfaces shall not be allowed unless specifically permitted.

3.1.11.4 Stainless steel components shall be thoroughly passivated after welding or being subject to any process that creates an oxide layer.

3.1.12 Provision for Handling Equipment

3.1.12.1 The generating set supplied to Unitywater shall have provision for lifting and handling during installation and overhaul or maintenance.

3.1.12.2 All parts normally lifted during periods of maintenance and weighing one tonne or over shall be marked with their weight.

3.1.12.3 Eyebolts shall be provided where necessary to facilitate handling and overhaul of the various parts of the equipment.

3.2. Generating Set Performance

3.2.1 Generating Set Output

3.2.1.1 The minimum electrical rating of the proposed generating sets subject to being of sufficient capacity to start and continuously run the connected loads and other minor electrical loads as listed in **Table 1**.

Table 1 – Generating Set Output Requirements

Item	Meaning
Location	Adjacent to the switchroom complete with ancillary equipment including weatherproof acoustic enclosures and weather protection structure.
Rating	Standby
Capacity	To be confirmed by the Contractor
Power Factor @ Nominated Duty	0.8 lagging
Number required	Defined in Project requirements
Voltage	415 Vac, 3-Phase, 4-Wire
Frequency	50 Hz
Maximum Engine Speed	1500 rpm
Step Load Acceptance	100% of site load or as specified by Unitywater
Time to Start Generating set	15 s
Time to Accept Site Load from Generating set Start	10 s

3.2.1.2 Prime Rating: The power the generating set shall produce when operating continuously. The generating set shall also be capable of producing 10% in excess of the prime rating for 1 hr in every 12 hr consecutive running.

3.2.1.3 Standby Rating: The power the generating set shall produce for 1 h in 12 h of continuous operation. The generating shall also be capable of producing at least 90% of the standby rating when operating continuously.

3.2.1.4 The rating of the generating sets hall be produced at the Alternator terminals when the set is operating under the specified site and service conditions.

3.2.1.5 Radiator ‘approach-air’ temperatures should be given considerable attention.

3.2.1.6 The Contractor shall also state in the Schedule the minimum loads at which each engine can operate with satisfactory behaviour without requiring excessive or abnormal maintenance.

3.2.1.7 The power output and fuel consumption of each engine shall comply with AS 4594 when using No. 2 fuel oil.

3.2.2 Acoustic Performance

3.2.2.1 The generating set shall be installed in a way that minimises the noise level external to the enclosure or building. All penetrations through the walls of the enclosure or building, the access doors and the interface between the enclosure and the footing shall be treated to minimise the escape of noise. Cooling air intakes and outlets shall be equipped with acoustics attenuators.

3.2.2.2 Where the enclosure consists of sheet metal that is otherwise not acoustically treated the inside of the cladding shall be lined with sound absorbing foam to minimise the radiation of sound. Where installed inside a room the building ventilation louvers shall be designed to provide the required acoustic performance.

3.2.2.3 Noise emissions from the completed generating sets installed in its enclosure, with the generating sets running at full load, shall not exceed 85 dB(A) at 1 m.

3.3. Outdoor Generating Set Enclosure

3.3.1 Description

3.3.3.1 A fully enclosed weatherproof enclosure (generator canopy) shall be provided to prevent ingress of moisture and rain whilst permitting adequate airflow for cooling and ventilation. Drains shall be provided where needed to divert any water which may enter the enclosure to grade. All vents and drains shall be fitted with screens to prevent the entry of vermin.

3.3.3.2 The enclosure shall be mechanically robust and shall allow good maintenance access to all equipment requiring servicing and inspection, particularly air, oil and fuel filters, fuel and oil pumps, starter motors, oil dipsticks, sensor connections, batteries and chargers.

3.3.3.3 A preferred general arrangement drawing is available from UW.

3.3.3.4 Open sets shall not be accepted by UW, and indoor sets are required to have sound attenuating and weather proof canopies in all cases, even when installed under a shelter or indoor as per Section 3.4.

3.3.2 Construction

3.3.2.1 Generator enclosures shall be constructed from folded and continuous seam welded sheet metal free from corrosion, dents and surface defects. Construction material type for specific locations as nominated below.

a. Locations 0 km to 5.0 km from Coastline:

   i. Stainless Steel Grade 316 of minimum thickness 1.5 mm, (under galvanised canopy outdoors);

   ii. Marine Grade Aluminium 5251 or 5083 of minimum thickness 3.0 mm, (enclosed within a sealed building with low atmospheric contaminants).

b. All other locations:

   i. Marine Grade Aluminium 5251 or 5083 of minimum thickness 3.0 mm, (under galvanised canopy outdoors);

   ii. Zinc Anneal minimum thickness 2.0 mm (enclosed within a sealed building with low atmospheric contaminants).

3.3.2.2 All generator enclosures shall be powder coated in accordance with *Pr9835* - *Specification for Electrical Installation at Treatment Plants.*

3.3.2.3 Hinged doors shall be provided where access is necessary for inspection and operation. Hinged doors or removable panels shall be provided where access is necessary for maintenance. All doors shall be fitted with hasp and staple style latches with Unitywater supplied locks. Removable panels shall be fitted with 316 stainless steel fasteners that shall only be removable with a tool or key.

3.3.2.4 Doors and removable panels shall be constructed with double returned edges and additional stiffeners where necessary to prevent distortion.

3.3.2.5 All doors shall be installed on lift-off hinges. A single lever handle shall be provided on each door which actuates wedge type latching mechanisms to secure the door in the closed position and to compress the sealing gasket. For doors in excess of 1200 mm high the latches shall engage at three points; top, centre and bottom.

3.3.2.6 Doors shall be arranged to open by at least an angle of 110°. Positive stops shall be provided to ensure that doors cannot open so far that they will come into contact with adjacent equipment and cause damage. Door stays shall be provided to allow the doors to be latched in the open position by maintenance personnel.

3.3.2.7 All doors and removable panels shall be provided with gaskets consisting of neoprene-covered foam rubber or equivalent. Gaskets shall be securely retained in a recess within the door. Gaskets shall bear on a flat sealing surface at least as wide as the gasket.

3.3.2.8 The roof shall be peaked to prevent the pooling of water or build-up of dust.

3.3.2.9 All fixings shall be minimum Grade 316 Stainless Steel.

3.3.3 Dimensions and Provision for Handling

3.3.3.1 All metal handles, hinges, knobs, screws, nuts, bolts etc. fitted externally shall be 316 stainless steel. All internal bolts, nuts, etc. shall be zinc plated (chromate converted).

3.3.4 Cable Entry

3.3.4.1 Adequate space shall be provided for the entry and termination of external power and control cables.

3.3.4.2 Cable entries shall be bottom entry only. Top or side cable entry is not permissible. Bolted, removable gland plates shall be provided for all cable entry points. Gland plates shall be fabricated from minimum 4 mm thick aluminium and shall be sealed with neoprene gaskets.

3.3.4.3 Cable supports shall be provided between the gland plates and the respective points of termination.

3.3.4.4 Access for cable connection shall be front entry.

3.3.5 Electrical Services within Enclosure

3.3.5.1 The following services shall be provided within the enclosure:

- General lighting to 400 lx maintained, using weatherproof luminaires. Provide one luminaire with an emergency battery pack with a backup period of 2 hours;
- Two double, IP56 rated, 10 A socket outlets, located on opposite sides of the set.

3.4. Indoor Generating Set Enclosure

3.4.1 For indoor generating sets, the generator canopy may be constructed from folded and welded panel quality sheet metal suitable for the environmental conditions.

3.4.2 All other requirements of Section 3.3 shall be met with regards to the enclosure.

3.5. Diesel Engine

3.5.1 General

3.5.1.1 The engine shall be of multi-cylinder, direct injection diesel type, suitable for driving a flexible-coupled alternator to provide the rated output at the site conditions.

3.5.1.2 The diesel engine shall be in accordance with AS 4594.

3.5.1.3 The engine shall be fitted with all protection devices necessary to ensure safe operation of the engine under the specified operating conditions. Such devices shall, where applicable, be integrated with other protection devices specified.

3.5.2 Lubricating Oil

3.5.2.1 The engine shall be supplied with lubrication oil sufficient for the initial fill of the engine and any anticipated usage during test running and commissioning. The oil shall be replaced after commissioning.

3.5.2.2 Pipework shall be provided for the discharging of used lubrication oil to a location accessible from outside the enclosure. A suitable valve shall be installed in the pipework. A ramp shall be provided over the pipework inside the enclosure.

3.5.3 Lubricating Oil Pump

3.5.3.1 The lubricating oil pump shall be of the positive displacement type and shall be driven from the engine by gears.

3.5.4 Lubricating Oil Filter

3.5.4.1 The engine lubricating oil system shall incorporate a full-flow engine-mounted filter of the replaceable element type fitted with an automatic by-pass valve. A switch shall provide indication to the control system of bypass operation.

3.5.5 Lubricating Oil Cooler

3.5.5.1 The engine shall be fitted with a direct engine-mounted full-flow oil cooler with an automatic by-pass valve. A switch shall provide indication to the control system of by-pass operation.

3.5.6 Air Intake Filter

3.5.6.1 The air intake filter systems shall provide clean, dry and dust and free air to both the diesel engine and the alternator.

3.5.6.2 A two-stage filter system shall be installed. The first stage shall filter outside air into the enclosed canopy and shall be mounted in the end wall of the enclosure closest to the alternator. The second stage shall comprise individual air cleaners mounted on the air intakes on each of the engine's turbo chargers.

3.5.6.3 Both filters shall be of the dry type with disposable paper elements.

3.5.6.4 Both filters shall have differential pressure gauges marked with clean/dirty zones to indicate when the filters should be replaced.

3.5.6.5 Charge air intercooler(s), if fitted, shall have a cooling capacity under the specified site conditions sufficient to adequately satisfy the cooling requirements of the diesel engine operating at 110% site capacity. An allowance for not less than 20% reduction in heat transfer capacity shall be made for fouling.

3.5.7 Exhaust Piping and Silencer

3.5.7.1 All exhaust pipework within the enclosure shall be insulated and lagged to prevent heat build-up in the enclosure. Pipework shall be connected to the engine via a flexible section arranged so that no weight is taken by the engine manifolds.

3.5.7.2 Noise levels shall not exceed 85 dB(A) at 1 m from the outside of the enclosure.

3.5.8 Engine Cooling System

3.5.8.1 A water-cooled radiator (cooled by an engine driven fan) shall be provided on the generating set unit. The system shall be sized to provide engine operation within the temperature limits specified by the engine manufacturer for the specified site conditions. The system shall be closed circuit with the necessary gauges, piping, ductwork and louvers.

3.5.8.2 The radiator shall be mounted near the end wall of the enclosure and shall be ducted to exhaust louvers to prevent hot air returning to the enclosure.

3.5.8.3 Any water treatment chemicals or additives necessary for the initial fill of the radiator shall be provided.

3.5.9 Engine Speed Control

3.5.9.1 The governor shall be provided with a manual means of adjustment for the purpose of setting operating speed and an approved means of locking the adjustment after setting.

3.5.10 Engine Fuel System

3.5.10.1 The engine shall be suitable for running on automotive diesel fuel in accordance with AS 3570.

3.5.10.2 The engine fuel system shall be suitable to accept and return supply from and to the engine header pipe.

3.5.10.3 Fuel lines shall be fitted with glass-type water traps.

3.5.10.4 The engine shall be fitted with a self-lubricated, positive displacement engine gear driven fuel transfer pump.

3.5.10.5 Solenoids shall be fitted with integral or separate 'power on' indication.

3.5.10.6 The engine shall be supplied with distillate sufficient for the anticipated usage during test running and commissioning.

3.5.10.7 Where the engine has a high fuel recirculation (i.e. > 20%) a fuel cooler shall be installed. The fuel cooler shall be installed between the return fuel line and the fuel day tank. An allowance for not less than 20% reduction in heat transfer capacity shall be made for fouling.

3.5.11 Engine Starting System

3.5.11.1 The engine shall be started electrically using batteries and starter motor(s) with lockable battery isolators. The batteries shall be provided with lockable isolators.

3.6. Alternator

3.6.1 Description

3.6.1.1 The alternator and regulator shall be of the solid state self-excited brushless type and shall be two bearing type.

3.6.1.2 The alternator shall have tropic proofed windings with minimum Class H rated insulation. The temperature rise rating shall be Class F.

3.6.1.3 The alternator shall be enclosed to a minimum of IP22 in accordance with AS 60529.

3.6.2 Excitation System and Performance

3.6.2.1 Excitation systems shall consist of permanent magnet generating sets coupled to electronic Automatic Voltage Regulators (AVRs). The AVR outputs shall be fed to the rotors via brushless exciters.

3.6.2.2 Exciters may be fitted within the alternator housing or mounted externally and directly coupled to the alternator shaft. Externally mounted exciters shall be provided with enclosures of the same degree of protection as the alternator.

3.6.2.3 Exciter output rectifier diodes shall be protected against voltage transients and surges.

3.6.2.4 The alternator efficiency shall be not less than 93%, and the alternator output waveform for line-to-line and line-to-neutral voltages shall be substantially sinusoidal for the entire load range. The deviation from sine wave shape at rated speed and rated voltage shall be less than 2% harmonic distortion.

3.6.2.5 The solid state voltage regulator shall have three phase sensing and shall maintain output voltage within ±1.5% from no load to full load at power factors from 0.8 to unity, over the entire temperature range. The response of the regulator and alternator shall be such that voltage regulation is achieved to within 3% of nominal voltage within 0.5 s.

3.6.2.6 Under short circuit conditions, the alternator shall produce approximately three (3) times full load current and shall be adequately protected from overheating under these conditions by means of field suppression after a pre-set delay.

3.6.3 Cooling

3.6.3.1 The alternator shall have a standard screen-protected, drip-proof fan ventilated enclosure to AS 1359.106 and shall draw its cooling air from within the generator enclosure. The exhausted cooling air shall preferably be ducted through louvers to the outside of the enclosure. This exhaust to the outside shall be designed to minimise entry of dust. Alternatively, an exhaust filter may be used.

3.6.4 Windings

3.6.4.1 Rotors shall be statically and dynamically balanced up to 125% of rated speed.

3.6.4.2 Stators shall be wound to 2/3 (120°) pitch. A fully interconnected damper (amortisseur) winding is required.

3.6.4.3 Stator and rotor windings shall be braced to withstand engine overspeed and electrical short circuits. Overspeed shall be 130% of normal rating, and short circuit shall be the full symmetric short circuit of the machine for a period of 1 s. Windings shall be tropicalised.

3.6.4.4 The alternator stator winding star point shall be connected to a neutral bar within the respective switchgear panel.

3.6.4.5 Stator winding temperature detectors shall be provided. Resistance Temperature Detector (RTD) shall be a 3-terminal type platinum resistance thermometer elements (characteristic curve - 100 Ω at 0 °C, 38.5 fundamental interval) and in accordance with AS 60947.8.

3.6.4.6 Detectors shall be wired either directly to programmable logic controller RTD input modules or indirectly via RTD evaluation devices.

3.6.4.7 Operation of one set of detectors shall initiate an ‘over temperature’ alarm at an appropriate temperature and operation of the other set shall initiate the opening of the generating set feeder circuit breaker in the switchboard.

3.6.4.8 Indication of individual or average temperatures measured by the detectors shall be displayed on the control panel.

3.7. Fuel System

3.7.1 General

3.7.1.1 Fuel will be stored in a day tank located within the generating set unit. From the day tank the engine fuel pump will draw fuel for the engine. A separate fuel storage tank, may be utilised when agreed to by Unitywater.

3.7.2 Storage Tank (where required)

3.7.2.1 Note additional storage tanks are no longer required by default. By default, the generator supplied shall only have an onboard tank (refer to Section 3.7.3).

3.7.2.2 The fuel storage tank shall be located close to the generating set with adequate allowance for maintenance access and inlet/exhaust air. It shall have a minimum capacity for 24 hours of continual operation at full load of the generating unit without refuelling and shall be of the above-ground type on a steel support structure. The minimum capacity storage required should not be less than 18 kL. The storage tanks shall be double wall and shall comply with the AS 1692 standard.

3.7.2.3 Where multiple generating sets are installed on site, storage tanks may be combined. However, the 'resulting' tank must be able to supply each generating set it supplies for the time specified in Section 3.7.2.1.

3.7.2.4 Each tank shall have at least the following fittings:

- One screwed inlet with stop valve and standard filling coupling accessible from ground level;
- One screwed outlet with isolating valve;
- One vent socket and insect proof vent;
- One 800 mm diameter access opening;
- One sight glass type level gauge with flanged or screwed connections;
- One drain line and valve from the lowest end;
- Lifting lugs;
- External level indicator.

3.7.2.5 The tank shall be installed with a maximum fall of 1:600 towards the drain end; the outlet being at the opposite bottom end.

3.7.2.6 All necessary valving to allow the transfer of storage tank to the day tanks shall be provided.

3.7.2.7 All tank auxiliaries, including contents gauges, fill and dip points, ladders and platforms, support cradles, overflows, vents, and drains shall be provided.

3.7.2.8 Interconnecting pipe work shall be installed on top of the slab in an enveloping pipe supplied by others and fixed to the structures elsewhere. This system shall feature flexible connections and isolation valves to each skid tank.

3.7.3 Day Tank

3.7.3.1 The day tank shall have a capacity for 8 hours while running the generating set at full load without refuelling.

3.7.3.2 If an additional storage tank is provided as per Section 3.7.2, the day tank shall be gravity fed from the fuel storage tank and the level of fuel in the day tank shall be controlled by a fail-safe solenoid-operated valve and a back-up heavy duty float valve.

A manual inlet isolating valve shall also be provided.

The day tank shall be provided with at least two independent overfill shut-off devices arrangement so that each will continue to function to prevent overfilling in the event of failure of the other.

3.7.3.3 The method of filling the day tank and the fuel level indication and control shall comply with AS 1940 and AS 1692.

3.7.3.4 A level gauge shall be provided on the day tank that is fully interfaced with the Plant control system (SCADA).

3.7.3.5 A low level switch shall be provided to cause an alarm when less than 30 min running of fuel remains in the tank. A very low level switch shall initiate an engine shutdown.

3.7.3.6 Top level of tank shall not be higher than the engine injectors.

3.7.3.7 A tank access hand hole is to be provided, with a clear opening of 150 mm diameter, fitted with oil resilient gas tight bolted lid.

3.7.3.8 The interior of the tank is to be cleaned of all scale and oxide formation prior to filling. The exterior is to be cleaned and painted.

3.7.3.9 Connection from the engine to the day tank shall be with 20 mm (minimum) supply and return lines. The delivery line shall be fitted with a 20 NB (minimum) steel ball valve and all fittings shall be steel except flexible connections (Strato-flex 211) to engine. The fuel line size shall be suitable for the fuel flow required for the generating set.

3.7.3.10 Oversized water separating filters between tank and engine shall be provided.

3.7.4 Piping

3.7.4.1 The design, fabrication, assembly, testing and inspection for piping works shall comply with the AS 4041 design standards.

3.7.4.2 Piping shall be heavy gauge screwed tubing to comply with AS 1074. No galvanised pipes are allowed.

3.7.4.3 Piping shall be laid to fall to tank at a minimum grade of 1:100. Piping joints shall be screwed and made gas and liquid tight.

3.7.4.4 Screwed connections are to be provided for all pipework connecting to the tank, fill pipe, vent pipe, dipstick and desludge, suction and level indicator. These last two are to be located adjacent the hand hole so as to be accessible.

Exposed horizontal runs of vent line shall be kept to a minimum. Vertical runs shall be true and plumb and adequately supported. All pipes shall be mechanically protected where required by regulations.

3.7.4.5 The supply line between the storage tank and the generating set day service tank shall be protected by the inclusion of a fusible link controlled watchman valve where the pipe enters the generating set enclosure.

3.7.4.6 Appropriate supports of the ‘Unistrut’ type shall be provided at suitable spacings.

3.8. Generating Set Control System

3.8.1 Control System Requirements

3.8.1.1 Each generating set shall be provided with a complete control, instrumentation and protection system necessary for the safe and reliable operation of the generating unit.

3.8.1.2 The generating set control system shall be based on Deep Sea series of generating set controllers. It shall be provided with interposing relays to interface with control devices.

3.8.1.3 The control system shall allow complete local operation of the generating set and shall interface with the Plant control system via a communications link for the remote control and monitoring of the generating unit operation parameters, alarm and trip conditions. The communications link may be Ethernet/TCP or RS-485.

3.8.1.4 Power supplies for the generating set control system and associated input and output circuits shall be provided by batteries and a battery charger.

3.8.1.5 The generating set control system shall be capable of synchronising the generating set to the mains power supply to allow seam-less changeover and testing.

3.8.2 Control Panel

3.8.2.1 The following controls shall be provided on each generating set control panel:

- Local/remote control selector switch;
- Key switch stop/run/start control switch;
- Emergency stop/Latch stop mushroom headed pushbutton, suitably located on the perimeter of the engine/alternator set.

3.8.2.2 The generating set control panel shall be mounted on the enclosure. All controls shall be accessible from outside the generating set enclosure.

3.8.2.3 Terminal strips shall be provided for all wiring between input and output modules and all devices internal and external to the control panel.

3.8.2.4 When the selector switch is set to local, operation shall be possible only from the local controls. Synchronising with the mains and closing of the external switchboard circuit breaker will be inhibited if synchronising capability is specified.

3.8.2.5 When the selector switch is set to remote, all local controls, except for the emergency stop pushbutton shall be inoperative. The generating set shall only be capable of being started remotely. Remote initiation of generating set shutdown will not stop the engine immediately but will cause the engine to be stopped after an adjustable programmed delay.

3.8.2.6 Operation of an emergency stop pushbutton shall shut down the generating set immediately irrespective of the mode.

3.8.2.7 Generating set voltage and current sensing devices will be provided in the external switchboard and signals from these devices will be made available at terminals in each generating unit control panel for use with local metering.

3.8.2.8 All wiring shall comply with the requirements set out in the switchboard section of *Pr9835 - Specification for Electrical Installation at Treatment Plants* if not specifically detailed within this specification.

3.8.3 Generating Set Controller

3.8.3.1 The generating set controller shall be based on a Deep Sea controller selected for the particular use of the generating set.

3.8.3.2 The controller shall allow all controls to be operated locally and remotely.

3.8.3.3 The generating set controller shall interface with the Plant control system via Ethernet/TCP or RS-485. All alarm and trip conditions noted in Section 3.8.4 Alarm and Trip Conditions shall be displayed on the Plant SCADA system.

3.8.3.4 As a minimum the following shall be able to be displayed on the generating set controller:

- Voltage of all phases including phase-to-phase and phase-to-neutral;
- Current of all phases;
- Frequency;
- Engine run hours;
- Fuel pressure;
- Fuel level;
- Shaft speed;
- Synchronisation status;
- Jacket water temperature;
- Jacket water pressure;
- Lube oil temperature;
- Lube oil pressure;
- Mixture temperature;
- Charge pressure;
- Exhaust gas temperature for each cylinder;
- Knock sensors; and
- Carburettor position.

3.8.3.5 The generating set controller shall be set to ‘slave’ with the ‘master’ controller residing with the ATS in the switchboard.

3.8.4 Alarm and Trip Conditions

3.8.4.1 All alarm and trip conditions shall be monitored by the generating set control system and shall be displayed on the generating set controller on discrete indicator lamps.

3.8.4.2 The alarm conditions shall include but not limited to the following:

- Low control voltage;
- Battery charger failure;
- Low oil pressure;

- Low oil level;
- High oil level;
- High water temperature;
- Low water level;
- Low fuel level;
- Alternator over-temperature;
- High differential pressure across fuel filter;
- High differential pressure across oil filter;
- High differential pressure across oil cooler;
- High differential pressure across air filter;

3.8.4.3 The trip conditions shall include but not limited to the following:

- Emergency Stop;
- Controller failure;
- Engine overspeed;
- Very low oil pressure;
- Very high water temperature.

3.8.4.4 Engine overspeed trip shall be via a fuel shut-off valve in addition to governor fuel cut off. All other trips shall be by operation of the governor to the no-fuel position.

3.8.4.5 All engine trips shall simultaneously provide a trip signal for the external switchboard circuit breaker wired to terminals.

3.9. Cable and Conductors

3.9.1 Cable and Conductor Size

3.9.1.1 All cables shall be new and shall be manufactured in accordance with AS/NZS 5000.1.

3.9.1.2 Power cable shall have a minimum conductor size of 2.5 mm² (Flex) and lighting cable shall have a 1.5 mm² (Flex) minimum conductor size.

3.9.1.3 Field control cabling shall have a minimum conductor size of 1.5 mm² (Flex)

3.9.1.4 Cables shall be sized such that the steady state voltage drop shall not exceed 3%, with consideration given to current rating, short circuit rating and fault loop impedance.

3.9.2 Low Voltage Power Cables

3.9.2.1 Low Voltage (LV) flexible power cables shall be selected from the following:

- Circular, copper conductor, 0.6/1 kV, PVC insulated, PVC sheathed (orange), complying with AS/NZS 5000.1, V-90 type cables.
- Circular, copper conductor, 0.6/1 kV, XLPE insulated, PVC sheathed (orange), complying with AS/NZS 5000.1, X-90 type cables.

3.9.3 Control Cable and Extra Low Voltage Cables

3.9.3.1 Control cables and ELV cables shall have the following specification:

- Circular, multicore, flexible stranded copper conductor, 0.6/1 kV, PVC insulated, PVC sheathed (orange), V-90 type cables (Flex);
- A minimum of 20% spare capacity or three (3) spare control cores, whichever is greater, shall be provided;
- Separate control cables shall be provided for analogue and digital signals;
- Wherever possible, separate cables shall be provided for input and output signals, including for marshalling cables.

3.9.4 Instrument Cables

3.9.4.1 Instrument cables and cables carrying 24 Vdc control signals shall be Olex Instrolex or approved equivalent, with the following specifications:

- Conductors shall be multi-strand, copper, of minimum size 1.5 mm² for single twisted pairs or twisted triples and 0.5 mm² for twisted multi-pairs or twisted multi-triples;
- 110 Vac PVC insulated, PVC sheathed (black), V-90;
- Each pair or triple in a multi-pair or multi-triple cable shall be numbered. Each individual wire in the pair or triple shall carry the number throughout its length;
- Every pair/triple in multi-pair or multi-triple cables shall be individually screened and the cable shall also have an overall screen;
- A minimum of 20% spare capacity or 1 spare pair, whichever is greater, in addition to any specifically specified spare cores or cables shall be provided, with the exception of cables terminated to final devices;
- Separate instrument cables shall be provided for analogue and digital signals;
- Wherever possible, separate cables shall be provided for input and output signals, including for marshalling cables.

3.9.5 RTD Cables

3.9.5.1 Cables between RTDs and associated transmitters shall be to the following specifications:

- Conductors shall be multi-strand, copper, of minimum size 1.5 mm² for twisted triples;
- PVC insulated, PVC sheathed (black), V-90 type cables.

3.9.6 Thermocouple Cables

3.9.6.1 Cables between thermocouples and their associated transmitters shall be wired using the correct thermocouple cable or thermocouple extension cable (as appropriate) to match the thermocouple materials.

3.9.6.2 Every pair in multi-pair thermocouple or thermocouple extension cable shall be individually screened, and the cable shall also have an overall screen.

3.9.7 Conductor Colour Coding

3.9.7.1 The conductor insulation colour coding shall be as per *Pr9835* - *Specification for Electrical Installation at Treatment Plants* and shall apply throughout the generating set and shall be continuous to the terminal point of each cable run.

3.9.8 Cable Installation

3.9.8.1 Wiring system (WS) classifications are described in AS/NZS 3013.

3.9.8.2 All components of the wiring system shall be suitable for the WS classification assigned to the wiring system. All cables exposed to direct sunlight shall have UV stabilised sheathing or shall be covered to the approval of Unitywater. Usage of double insulated cables with an outer sheathing of non-UV-stabilized material will not be accepted.

3.9.8.3 Wiring systems installed in positions where they are likely to be subject to mechanical damage shall be adequately protected in accordance with AS/NZS 3000.

3.9.8.4 Cables shall be installed on cable ladder or inside metal conduit. Covers shall be provided on cable ladder installed outside the enclosure to protect the cabling from direct sunlight.

3.9.8.5 Cables shall be installed in continuous lengths. In-line joints are not permitted.

3.9.8.6 Where possible, cable slack or loops shall be provided adjacent to terminal boxes and equipment to facilitate servicing and re-termination.

3.9.9 Terminal Strips

3.9.9.1 All control wiring shall terminate onto tunnel type, TS32 rail mounted terminal blocks. The rail mounted terminal strip may be mounted horizontally or vertically with consideration given to other equipment. Terminals shall be grouped according to function.

3.9.9.2 Control terminals for different voltage circuits shall be grouped and separated from each other by approved barriers.

3.9.9.3 Each terminal strip shall have at least 20% spare capacity for future terminals.

3.9.9.4 Terminals shall be sized and arranged so that one wire only is terminated in any one side of a terminal. Extra terminals with bridging connector links shall be provided where multiple wires are to be terminated.

3.9.9.5 Where screened or shielded cable is used, a terminal (usually earth) shall be provided to terminate the screen adjacent to the core terminals and on the same rail.

3.9.9.6 All cores of control cables shall be terminated together in a group.

3.9.9.7 All terminals and terminal strips shall be numbered in accordance with the drawings.

3.9.9.8 Terminals shall be selected from the mandated equipment list as specified in *F10678* - *Accepted Electrical Equipment List*.

3.10. Earthing and Bonding

3.10.1 Earthing System

3.10.1.1 The generator shall be connected to the Multiple Earth Neutral (MEN) of the main switchboard which the generator supplies.

3.10.1.2 A MEN connection point shall be supplied for mobile generating sets but not connected.

3.10.2 Enclosure Earthing

3.10.2.1 All metal parts of enclosures including doors, other than current carrying parts, shall be continuously bonded and earthed.

3.10.2.2 A dedicated Earth terminal shall be provided for each external cable.

3.10.3 Equipotential Bonding

3.10.3.1 Equipotential bonding as a minimum shall include the following items bonded to the site Main Earth Bar/Grid:

- Metallic pipework;
- Metallic enclosure;
- Any lightning protection systems;
- Cable supports;
- Any extraneous conductive parts.

3.10.3.2 All metallic cable ladder and other supports shall be earthed.

3.10.3.3 All expansion joints in cable ladders and cable trays shall be bonded to ensure continuity.

3.10.3.4 The minimum size bonding and earthing conductors for cable ladders shall be as per AS/NZS 3000 for the largest active conductor.

3.10.3.5 All metal gland plates shall be earthed.

3.10.3.6 Glands fitted to plastic or painted steel gland plates shall be earthed using proprietary gland earthing lugs.

3.10.3.7 Multiple earth connections within equipment shall terminate at earth bars, with one conductor per screw, stud or tunnel type terminal. Tunnel type terminals shall have two screws.

3.11. Labelling

3.11.1 Name Plates

3.11.1.1 A large name plate shall be attached to the front of each generating set enclosure.

3.11.1.2 Name plates shall be stainless steel with black lettering.

3.11.1.3 Name plates shall be fixed with stainless steel screws.

3.11.1.4 The name plates shall display the following details (as a minimum):

- Tag Number;
- Name;
- Voltage;
- Power Rating (Prime and Standby);
- Switchboard Connection Circuit Breaker.

3.11.2 Arc Flash Label

3.11.2.1 An arc flash label plate shall be fitted to the generator, adjacent to the protective device.

3.11.2.2 The label shall be in accordance with *Pr10618 - Specification for Power Systems Analysis and Arc Flash Studies*.

3.11.3 Rating Plates

3.11.3.1 A rating plate shall be attached to the front of each generating set enclosure. The rating plate shall be located below the name plate.

3.11.3.2 All information required by the applicable standards shall be included on each rating plate.

3.11.3.3 Rating plates shall be stainless steel with black lettering.

3.11.4 Equipment and Component Labels

3.11.4.1 All other labelling requirements are detailed in *Pr9835 - Specification for Electrical Installation at Treatment Plants*.

3.11.4.2 Labels within the generating set enclosure may be considered ‘indoor’ labels.

3.11.5 Label Schedule

3.11.5.1 A label schedule showing details of each label shall be submitted for approval prior to manufacture of the labels.

3.12. Batteries and Battery Chargers

3.12.1 Batteries

3.12.1.1 Batteries shall be AGM type.

3.12.1.2 Batteries shall be of sufficient capacity to enable 10 consecutive engine starts from cold.

3.12.1.3 The batteries shall be positioned to minimise cabling to the starter motor.

3.12.1.4 Generally, the batteries will be a 24V DC system for cranking and engine starting.

3.12.1.5 All other battery requirements are outlined in *Pr9835* - *Specification for Electrical Installation at Treatment Plants*.

3.12.1.6 A separate battery cover with easy access for maintenance purposes shall be provided and fixed in place prior to any operation.

3.12.1.7 Batteries shall be provided with a lockable isolator, mounted adjacent to the batteries.

3.12.2 Battery Chargers

3.12.2.1 Battery chargers shall be of the smart charger type with mains failure indication and a common alarm contact and individual indication for:

- Battery voltage high;
- Battery voltage low;
- Loss of AC;
- Battery ground;
- Charger fault.

3.12.2.2 The common alarm contact shall be wired to the generating unit controller and display ‘Battery Charger fault’ alarm on controller and Plant Control System. The battery charger shall have AC mains circuit breaker and DC fuses.

3.12.2.3 Both the batteries and the charger shall be located inside the enclosure, with easy access to the batteries for maintenance purposes.

3.12.2.4 All other battery charger requirements are outlined in *Pr9835* - *Specification for Electrical Installation at Treatment Plants*.

3.13. Painting

3.13.1 The enclosures and control panels, engine, alternator, radiator and internal structural surfaces may be painted in accordance with the manufacturer's recommended coating system and colour, subject to approval by Unitywater.

3.13.2 All preparation and painting shall be carried out strictly in accordance with the paint system manufacturer’s recommendation.

3.13.3 Metal finishing, the preparation and pre-treatment of surfaces shall comply with the AS 1627 series of standards or equivalent standards.

3.13.4 The complete enclosure shall be surface protected to suit the site environmental conditions.

3.13.5 Surface preparation and paint systems shall be selected to give a life of not less than 15 years to first maintenance.

3.13.6 Primers based on zinc chromate or red lead and topcoats utilising polyurethane shall not be used under any circumstances. Isocyanide based materials also shall not be used under any circumstances.

4. Testing, Commissioning and Documentation

4.1. Factory Acceptance Testing

4.1.1 General

4.1.1.1 The Supplier shall perform Factory Acceptance Tests (FATs) on each diesel generating set system prior to shipment to site.

4.1.1.2 FATs will be carried out on each complete system. All components shall be present for the FAT.

4.1.1.3 FATs shall fully comply with the requirements of the reference standards.

4.1.1.4 FATs shall include:

- Detailed mechanical inspection;
- Detailed electrical inspection;
- Verification of correct labelling;
- Review of setup parameters for all digital control systems (if applicable);
- Functional testing of all control, indication, measurement and protection circuits;
- Functional testing of all interfaces to the Plant control system for remote monitoring and control (this may be simulated);
- Performance testing to demonstrate the equipment meets the specified performance requirements;
- Insulation resistance tests (before dielectric withstand tests);
- Dielectric withstand tests (power frequency tests);
- Insulation resistance tests (repeated after dielectric withstand tests);
- Load tests (4 hours minimum duration) using resistive load banks;
- Load step tests (to verify transient voltage and frequency performance) for load steps of 0-50%, 50-100%, 100-50% and 50-0% of full load using resistive load banks;
- Harmonic voltage distortion tests for open circuit, 25%, 50%, 75% and 100% of full load conditions using resistive load banks;
- Inspection of all loose-supplied equipment;
- Review of manufacturing inspection and test documentation and records;
- Review of manufacturing defect lists/punchlists;

4.1.1.5 Unitywater shall be given the opportunity to witness the factory tests.

4.1.1.6 The results of all factory tests shall be available for review during the tests.

4.1.1.7 A comprehensive FAT Report shall be submitted to Unitywater for approval. The FAT Report shall include:

- Results of all tests;
- Copies of any test oscillograms, graphs, printouts, etc.;
- Copies of manufacturing inspection and test documentation and records, follower cards, etc.;
- Copies of factory defect lists/punchlists;
- Copy of the completed Factory ITP;
- Statement confirming compliance with the specified requirements.

4.1.1.8 All defects arising prior to or during the FATs shall be rectified prior to the respective equipment being shipped to site.

4.2. On Site Testing and Commissioning

4.2.1 General

4.2.1.1 After installation at site, the Supplier shall perform detailed site tests to verify that each generating set system is fully complete and able to meet the specified performance requirements.

4.2.2.1 Site tests shall fully comply with the requirements of the reference standards.

4.2.3.1 As a minimum, the following tests shall be performed:

- Detailed mechanical inspection;
- Detailed electrical inspection (including termination of field wiring);
- Verification of correct labelling;
- Functional testing of all control, indication, measurement and protection circuits;
- Functional testing of all interfaces to the Plant control system for remote monitoring and control (this must not be simulated);
- Performance testing to demonstrate the equipment meets the specified performance requirements;
- Load tests (4 hours minimum duration) using plant load or resistive load banks if the plant cannot supply full load;
- Inspection of all loose-supplied equipment;
- Review of assembly inspection and test documentation and records;
- Review of assembly defect lists/punchlists.

4.2.4.1 Unitywater shall be given the opportunity to witness the site tests.

4.2.5.1 The results of all site tests shall be available for review during the tests.

4.2.6.1 A comprehensive Site Test Report shall be submitted to Unitywater for approval after completion of the respective site tests The Site Test Report shall include:

- Results of all tests;
- Copies of any test oscillograms, graphs, printouts, etc.;
- Copies of site defect lists/punchlists;
- Copy of the completed Site ITP;
- Statement confirming compliance with all specified and legislated requirements.

4.3. Quality Assurance and ITPs

4.3.1 Quality Assurance

4.3.1.1 The Supplier shall implement a quality system that complies with the requirements of AS ISO 9001 for all work on the diesel generating sets.

4.3.1.2 Quality records shall be provided by the Supplier in accordance with Documentation and Deliverables Section 4.4 of this Specification.

4.3.2 Inspection and Test Plans

4.3.2.1 The Supplier shall submit to the Principal for approval 2 project-specific Inspection and Test Plans (ITPs) for the generating sets:

- Factory ITP - Covering all off-site activities i.e. engineering, design, supply, manufacture, factory assembly, factory testing, resolution of factory defects/punchlists, release for delivery, preparation for transport, etc.;
- Site Testing ITP - Covering all on-site testing, resolution of site defects/punchlists, handover, etc.

4.3.2.2 The ITPs shall identify the standards and/or procedures as well as the acceptance criteria that shall apply for each stage in the ITPs.

4.3.2.3 All standards, procedures and acceptance criteria included in the ITPs shall comply with the requirements defined in this specification.

4.3.2.4 The Supplier shall perform all work on the generating sets in accordance with the approved ITPs.

4.3.2.5 Unitywater may apply witness points and/or hold points on various stages of the ITPs.

4.3.2.6 Unitywater may elect to appoint third party inspector(s) to witness inspections and tests.

4.4. Documentation and Deliverables

4.4.1 General

4.4.1.1 The Supplier shall provide documentation for the generating sets in accordance with the project requirements and other details within this specification.

4.4.1.2 All drawings shall comply with *Pr8843 - Specification for Drawing, Document and Equipment Tag Numbering*.

4.4.1.3 Two (2) hardcopies of all documents shall be submitted to the Unitywater.

4.4.1.4 All documentation shall be submitted electronically in the following file formats:

- Drawings — AutoCAD (dwg) and Adobe Acrobat (pdf);
- Spreadsheets — Microsoft Office Excel (xls or xlsx);
- Specifications, procedures, etc. — Microsoft Office Word (doc or docx);
- Training presentations — Microsoft Office PowerPoint (ppt or pptx);
- Supplier datasheets, etc. — Adobe Acrobat (pdf) and native format (xls, xlsx or doc, docx)
- Other types — To be approved by Unitywater

4.4.1.5 Standard drawing sizes are as per the SEQ Asset Information Specification.

4.4.1.6 All documentation other than drawings shall be sized A4.

4.4.1.7 A complete, detailed and fully customised set of drawings shall be provided for each system.

4.5. Spare Parts and Tools

4.5.1 Operating Tools

4.5.1.1 The Supplier shall supply 1 complete set of operating tools for each generating set.

4.5.2 Spare Parts and/or Tools

4.5.2.1 The Supplier shall provide a priced list of all spare parts and/or tools. Prices shall include delivery to site and packing suitable for long-term storage.

4.6. Preferred Equipment List

Refer to F10678 – Accepted Electrical Equipment List.

5. Appendices

Refer to following pages.

Appendix A – Definitions/Acronyms

The following definitions, abbreviations and acronyms are used throughout this specification.

Term	Meaning
AC or ac	Alternating current
AI	Analogue Input
AO	Analogue Output
CB	Circuit Breaker
CCA	Copper Chromate Arsenate
DC or dc	Direct current
ELV	Extra Low Voltage as defined by AS/NZS 3000
HRC	High Rupturing Capacity
IEC	International Electrotechnical Commission
LV	Low Voltage as defined by AS/NZS 3000
MCC	Motor Control Centre
MEN	Multiple Earth Neutral
PCB	Polychlorinated Biphenyls
PVC	Polyvinyl Chloride
RPEQ	Registered Professional Engineer of Queensland

Appendix B – References

General

All design, equipment and workmanship shall conform to the most recent requirements of relevant statutory local, state and Commonwealth requirements and applicable, current Australian Standards.

Where no Australian Standard exists, work shall conform to the most applicable, current IEC Standard.

Reference to specific clauses of the various codes is intended to highlight those points and shall not be taken to imply a lesser importance for all other applicable clauses.

All the works shall conform to the Rules and Regulations of the Statutory Authorities having jurisdiction over the Site.

If the requirements of this Specification do not articulate the minimum requirements of the statutory regulations and standards, the regulatory requirements are taken to apply. If the requirements of this Specification are more exacting than the minimum requirements of the statutory regulations and standards, the former shall apply.

All Materials, fittings, accessories and equipment supplied by the Contractor shall be new and the best obtainable of their kind and shall comply in all respects with the requirements of the relevant Standards Australia specifications.

The following Legislation, related Regulations and Codes apply in relation to this Specification:

- *Electricity Act 1994* (Qld);
- *Electrical Safety Act 2002* (Qld);
- *Electrical Safety Regulation 2013* (Qld);
- *Electricity Regulation 2006* (Qld);
- *Work Health and Safety Act 2011* (Qld); and
- *Work Health and Safety Regulation 2011* (Qld).

Relevant Unitywater documents that relate to this specification

Document No.	Title
F10678	Accepted Electrical Equipment List
Pr8843	Specification for Drawing, Document and Equipment Tag Numbering.
Pr10618	Specification for Power Systems Analysis and Arc Flash Studies.

International and Australian Standards referenced within this specification

Standard	Title
AS 1074	Steel tubes and tubulars for ordinary service
AS 1081	Acoustics – Measurement of airborne noise emitted by rotating electrical machinery
AS 1101	Graphic symbols for general engineering
AS/NZS 1102	Graphical symbols for electrotechnical documentation
AS/NZS 1170.2	Structural design actions – Wind actions
AS/NZS 1170.4	Structural design actions – Earthquake actions in Australia
AS 1359.106	Rotating electrical machines – General Requirements – Methods of cooling (IC Code)
AS 1375	SAA Industrial fuel fired appliance code
AS 1627	Metal finishing – Preparation and pre-treatment of surfaces
AS 1692	Steel tanks for flammable and combustible liquids
AS 1940	The storage and handling of flammable and combustible liquids
AS/NZS 2053	Conduits and fittings for electrical installations – General requirements
AS 2184	Low voltage switchgear and control gear – Moulded-case circuit-breakers for rated voltages up to and including 600 Va.c. and 250 Vd.c.
AS/NZS 2373	Electric cables – Twisted pair for control and protection circuits
AS/NZS 3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3008.1.1	Electrical installations – Selection of cables – Cables for alternating voltages up to 0.6/1 kV – Typical Australian installation conditions
AS/NZS 3010	Electrical installations – Generating sets
AS/NZS 3013	Electrical installations – Classification of the fire and mechanical performance of wiring system elements
AS/NZS 3439.1	Low-voltage switchgear and control gear assemblies – Type-tested and partially type-tested assemblies
AS 3570	Automotive diesel fuel
AS 4041	Pressure piping
AS 4594	Internal combustion engines – Performance
AS/NZS 5000.1	Electric cables – Polymeric insulated – For working voltages up to and including 0.6/1 kV
AS 60598.1	Luminaires - General requirements and tests (IEC 60598-1, Ed. 7.0 (2008) MOD